

Predicting Orion Pad Abort Vibrations to Keep Artemis Astronauts Safe

NASA's Artemis Program aims to transport humans to the Moon, and eventually Mars, and return them safely to Earth via the Orion crew module. During launch, Orion is outfitted with a Launch Abort System (LAS) that can propel the astronauts to safety in the event of a problem. The LAS uses a motor that produces four large high-speed exhaust plumes that flow along the sides of the LAS, generating extremely strong acoustic vibrations. Using detailed turbulence-resolving simulations, we compared the Pad Abort 1 flight test—where the LAS accelerates to over ten times Earth's gravity—to a case where the LAS is at rest. Results provide a better understanding of the effects of acceleration and banking on the vibration levels on the LAS fairing, which protects the crew module.

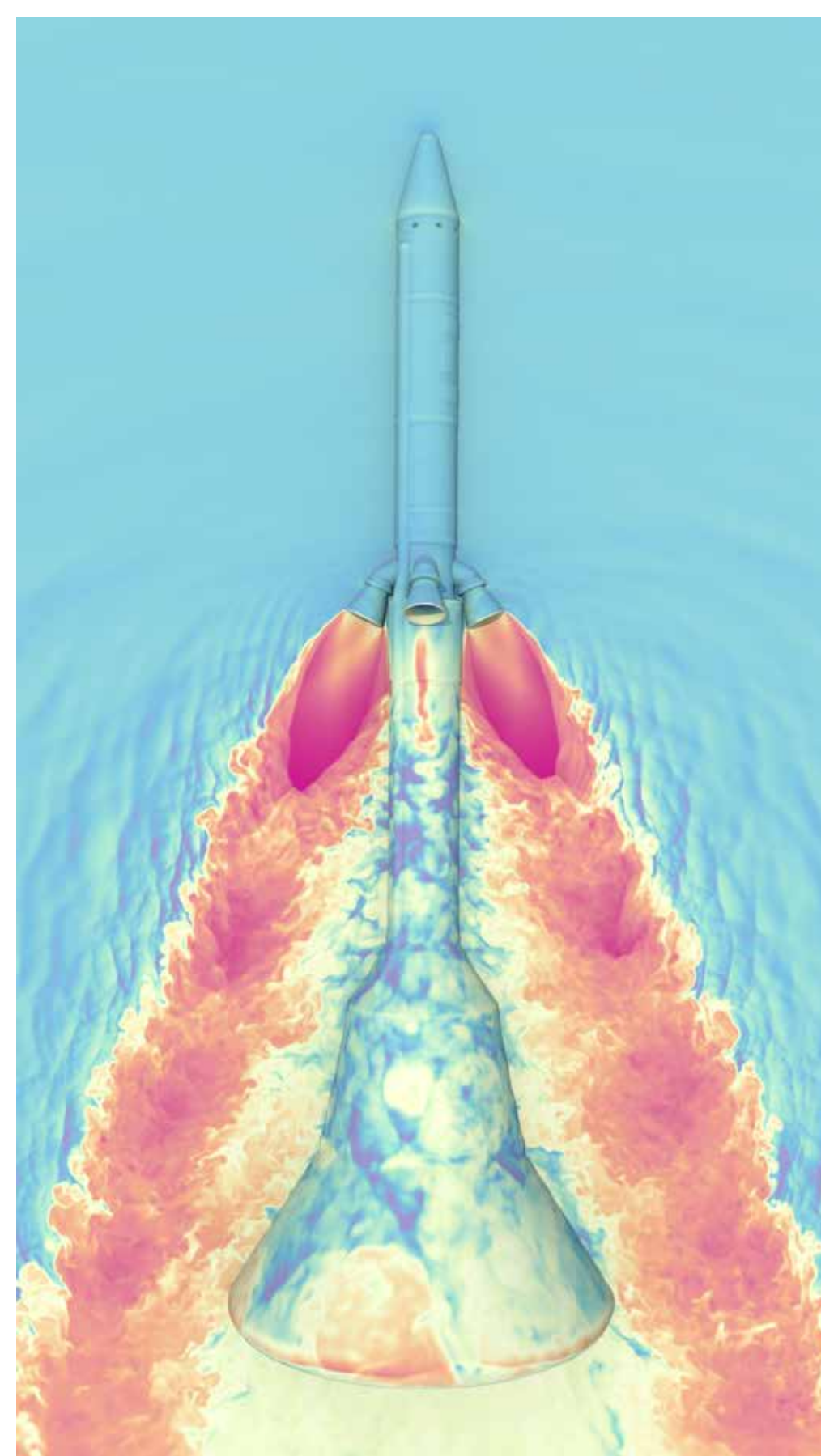


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Snapshot of the Pad Abort 1 flight test simulation at 1.25 seconds after ignition. Particles are seeded at the abort motor nozzles, and move with the unsteady turbulent plumes. The particles are colored by the exhaust gas velocity magnitude, where white and orange indicate regions of high-speed flow and strong vibrations; darker colors indicate slower flow.

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Snapshot of the Pad Abort 1 flight test simulation showing the detailed turbulent exhaust plume physics captured. Density (red is low, blue is high) is shown on the vehicle surface and a plane cutting through two abort motor nozzles. The hot, high-velocity exhaust gas has a lower density than air when it exits the nozzle. Its difference in speed with respect to the slower moving air around the vehicle creates turbulent eddies that result in pressure fluctuations on the vehicle surface.

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